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THE increased interest in the Scientific Society is very gratifying, especially to those who have labored to keep it in successful operation. The attendance and interest manifested by all shows a deep appreciation of the benefits to be derived by the study and discussion of some of the most inviting problems and phases of engineering. The papers read so far have been exceptionally good and reflect great credit upon the men, not only for the admirable manner in which they have been presented, but also because they show careful preparation and close study of the subject under discussion.

THE base ball season is fast approaching, and in a few weeks the diamond will resume its place in athletics. With the material already on hand the prospects for a successful nine were never brighter. Nearly all of last year's team are still with us, and the few vacancies that will have to be filled will find abundant material in the other classes to make up any deficiencies that may have resulted from the graduation of some of the men of last year.

A schedule has been arranged for the spring and a number of games have been reserved to be played on our own ground. There are still several open dates and a number of offers of games for the home grounds that have not, so far, been filled, partly because of the delay necessary in arranging so many games, and a desire to reserve a few open dates until the season has fairly begun.

Already signs of activity have been manifested on several of the beautiful days we have had in the last few weeks. With the interest already shown and the splendid prospects, the management promises that the base ball enthusiasts will not be disappointed in either the work of the nine or the number of games that will be played.

THE perplexing question of the selection of a thesis subject seems to be holding the undivided attention of the Senior class at present. Many are the serious thoughts that are being given this important topic. Some have already selected their subjects and have been working out the various lines of experiments that are possible in the short time at their disposal. Others are still deep at sea as to what the subject shall be. The selection of the thesis is a rather difficult matter for most men, as their inclinations greatly vary. Many admirable subjects offer themselves and present enticing lines of work, but the impracticable nature and the lack of time and apparatus with which to thoroughly investigate, renders them unfit for very serious consideration.

The choice is as varied as the man, each has his hobby and would naturally prefer to carry out a series of investigation along this line, but often the hobby is of such a momentus nature that he is utterly unable to deal with it in a satisfactory way.

As the time to hand in the subjects draws near he is less and less satisfied with his choice and would often throw away a very suitable subject; but fortunately it has been customary for the faculty to have the final decision in the matter and decide from their knowledge of long acquaintance with the men, the appropriateness of the subject considered. All thesis subjects are to be handed in by the fifteenth and then a week will be given, the last of the month, for preliminary work and formation of outlines of the work to be carried on during the six weeks at the end of the year which are devoted exclusively to thesis work.

ALTHOUGH the Seniors are deeply engrossed in the selection of their theses, still a few spare moments have been devoted to another very interesting question: "Will we have a Senior trip?" Last year the class was bitterly disappointed in not having the annual trip, although it had been promised and they fully expected to go. The present class have already been discussing the possibility and probability of their enjoying a trip during the spring term. These excursions have always proved so very interesting and profitable that the men look forward to its realization as a part of the course of instruction and one of the pleasantest events of the four years of work at the Institute. It is sincerely hoped that this custom will not be abandoned, not only for the sake of the present Senior class, but also for the classes that are to come.

THE subject of "Entrance Requirements for Engineering Colleges" has received considerable notice in the scientific journals of the last two months. The *Engineering Record* has devoted considerable space to the discussion of the subject both from the engineer's standpoint and that of professors of various institutions of engineering.

The prevailing opinion seems to be in favor of low entrance examination; that is, in making the requirements for entrance consist only of the branches of mathematics taught in the high schools and preparatory schools, omitting physics, chemistry and the higher branches of mathematics, but raising the standard in English.

Nothing is gained by placing the fundamental subjects of engineering upon the list of entrance requirements, as the student, in the majority of cases, has not received the thoroughness of preparation which will be of the greatest service. The attempt should not be made to obtain from the secondary schools what they are not prepared to give, either from lack of facilities and instructors or because the mind of the student is not mature enough to grasp the principles of mathematics and the natural sciences which form the essential foundation of engineering. In order that the students should be properly qualified for entrance to engineering schools where the entrance requirements are high, it would become necessary to raise the standard of these schools. Perhaps not over ten per cent. of the graduates of the high schools enter college—the greater majority go into business of a commercial nature. The high schools are in no way intended as preparatory schools for higher education; in fact, they were founded to give the student who does not expect to enter college a broader and wider education than could be obtained from the common schools. The mathematics and natural sciences as taught in these schools are entirely adequate for the demands made by the majority of the students.

Such courses are excellent in their way, but the knowledge imparted is not such as will be most beneficial to the student in engineering schools, in fact it is often found to be better not to have had any preparation in the natural sciences, as the vague ideas already formed are often hard to overcome and one of the functions of the schools of science is made more difficult; that is, a careful and thorough knowledge of the fundamental principles.

An academic course, which gives a thorough training in English, is much desired as preparatory to the technical course, as the time devoted to literature and the languages is necessarily limited, while the subjects of mathematics and natural sciences are given the most thorough attention.

READING is a habit that must be cultivated, it is not natural, the capacity must be acquired. This is a day of general reading and no man can hope to be successful in business or professional life who has not a desire for wide reading. The college days offer the broadest and most useful field for reading and if the habit is not acquired then it will in all probability never be very extensively cultivated. This is a distinctive period in ones life, and the taste and inclinations formed then will, in a measure, influence the whole after life. Here one should learn the art of reading, not to pour over a book, turning page after page. More is necessary, more than a passing glance must be given.

College days are formative, in that they determine to a large measure what our future shall be. The habits acquired here will go with us throughout life. We live our college days only once, and the best of the opportunities must be made so that we will be strengthened and better equipped afterwards. There is a tendency to look upon the life of a student as narrow, as primarily for class work. This is however no more all of college life than of the world. College is not entirely for the cultivation of intellectual pursuits, but it is wider and broader, for systematic culture, physical, social and intellectual. One of the greatest factors in education is reading, and one of the greatest aids a college training can give to a man is the cultivation of a taste for reading, systematic and varied, to encourage him to read, and to take up a course of reading in the current literature of the day.

College men in general do not read the magazines and literature of the day. Why? Because they find in it so little of interest, so much that is unknown. Their interests are centered on the scholastic side of education, and the broader and nobler side of life is lost sight of. They are forming habits of study and work that is limiting their horizon, and the many suggestions that would come to them in their work are lost.

Many men have the desire and ambition to become broad minded but they persuade themselves that they have no time for reading, at present; the all important question is to master what is already in their hands, feeling that when out in the world time will then be found for the lost opportunities of the present. But these lost moments are never regained and the habit is lost, in a measure, and less time is to be found.

The crisis is reached early and must be passed. When once the desire is established and the habit formed, reading will become a part of your daily existence, and you will become as dependent on reading as on the necessities of life.

Time is scarce, and the first lesson to learn is how to make the best of it. With the duties of college much of the reading must be done during spare moments, while you wait for a class, or are at home. If the habit of spending the spare moments while waiting for a class be given to reading in the library, thoughtful, careful reading along the lines of your work, or on the interesting topics of the day, the amount of information gained in these odd moments will be beyond measure. Then reading is a rest and not a burden to the mind, it refreshes and quickens the perception and becomes a stimulus for greater exertions.

The Approximate Value of a Measured Quantity.

BY EDWIN PLACE.

LAST year the present writer made a partial test of a small alternating current motor in the laboratory, and in the May TECHNIC showed, among other things, a curve of efficiencies of the motor at various loads. From that curve it appeared that the maximum value ran as high as 90%. It seemed at the time that this was exceptionally high for so small a motor, and it was so stated in that article. However, on looking over the calculations, a short time afterwards, it was found that the remarkably high values were due to the displacement of the decimal point one place too far to the right; thus making them all ten times too great. The writer does not wish to offer any excuse to the public for such a blunder on his part. He acknowledges it frankly and greatly regrets that it should have happened.

The above instance illustrates very well the importance of the decimal point in numerical calculations. Its function in a number of the decimal system of notation is to separate the intregal part from the fractional. That portion to the left represents the number of whole units; the portion to the right, the fraction of a unit which is to be added to the whole number. When the size of the units by which a magnitude is measured bear the relation of ten or multiple of ten to each other, the *measure* of that magnitude can be expressed in any of these units by merely moving the decimal point to the right or left. Thus 2347 cents is equivalent to 23.47 dollars. A length of 4129.6 centimeters is equivalent to 412.96 decimeters, 41.296 meters or .041296 kilometers, etc. The point, then, in the decimal system of measurements serves to show, by its position, what is the size of the unit used to measure the given magnitude and has nothing to do with the real magnitude of the quantity itself. The significant figures of the number properly express magnitude, for in the examples just given they remain the same irrespective of the size of the units. These are matters of common knowledge with everyone perhaps, yet it is not unusual to find that a student gauges the accuracy of a measurement by the position of the decimal point in the number. Thus he measures a small distance and finds it to be, say, .0033 centimeters. Because he gets the value to the nearest ten thousandth of a cm. he infers it must be a very accurate measurement, whereas it may be really as much as 3% from the truth. Again in calculating a quantity from certain measurements all the significant figures resulting from the arithmetical work are often retained in the final results, amounting to as many as eight or ten in some cases. When questioned as to the ultimate accuracy of such results, the student argues that he has made no mistakes in the calculation—and figures won't lie. Such undoubtedly is true. The veracity of arithmetical processes and of figures resulting from them are not to be doubted. The multiplication table or seven-place logarithms are not to be held responsible for the numbers they operate on, and the final result will be no nearer the truth than are the numbers used at the start. If these numbers express only roughly the values of the quantities measured, no amount of refinement in computation upon them can give exact values in the end.

Only a comparatively few of the simpler physical magnitudes admit of direct measurement. A length may be so measured obviously by placing it on graduated scale and reading off the number of divisions which lie between the extremities of the length to be measured. The greater number of quantities, however, can be measured only by some indirect method. In every case the measurement, whatever be the nature of the quantity, must be made in terms of length, and length only. This will be apparent to everyone when one remembers that nearly every physical apparatus contains one or more divided scales, either circular or straight, upon which, during the course of the experiment, divisions or lengths are read off. Or, perhaps, in addition some dimension of the apparatus must be known. In some instances, as in weighing by a balance, the mass to be measured is brought into equilibrium with certain standards of mass of known value. By this method of measurement, as by other "zero" methods, the scale itself is not read, but the value of the quantity is deduced from the known value of the standards used and certain other data belonging to the apparatus.

Granting, then, that every sort of measurement involves the reading of a divided scale, it is evident that the value of the quantity will finally depend upon the value of scale readings and other measured lengths. Reading the scale consists in merely observing the position on the scale which a moving index or pointer takes under a certain condition and the "zero" position of it also. The number of whole divisions from the zero will be shown by the number marked on the scale. But where, as is generally the case, the index falls between two division lines, the fraction of a division must be determined as well, if a more accurate value of the reading is desired. In certain cases the fraction is found by a vernier or some other interpolating device, but usually it is done by estimating with the eye to quarters or tenths. When tenths of a division are estimated it is shown by another significant figure in scale reading. The number therefore approximates more nearly the true value than if the reading of tenths had been omitted. Of course the estimation of tenths of a division refers to the smallest division into which the scale is divided. If the number of scale divisions from the zero is large it may be sufficiently accurate to read only the number of whole divisions. But if, as is often the case, this be small, it becomes important to know the fraction with considerable precision. If a measurement consisted only in counting the number of whole divisions the result could be known with certainty and be expressed exactly. With the measurement of a continuous quantity like length it is not so. One can, for instance, count the number of nails in a given pile of them with absolute certainty, but he cannot determine their combined mass in terms of a given unit with the same degree of certainty. The reason is obvious. In the one case the quantity and the unit are commensurate with each other; in the other they are not commensurate.

Admitting, then, that there are limitations to accuracy in reading a scale, it is not difficult to see how near the truth the result of certain measurements approximates. Suppose the diameter of a particular wire as measured by a micrometer screw is 24.6 divisions, no error in the screw or in the graduation of the scale; i. e. 24 whole divisions and a fraction besides. The estimated value of the fraction is 0.6 and is supposed to be the nearest tenth of a division according to the best judgment of the observer. Since 0.6 is only a guess anyway, it is fair to assume that this value may be as much as half a tenth greater or half a tenth less than the true value. That is to say, the observer felt confident it was nearer 0.6 than either 0.5 or 0.7. It may then be in error a whole tenth from the truth. Now an error of 0.1 in 24.6 is equivalent to one part in 246. If the micrometer reads to hundredths of a millimeter the reading gives 0.0246 centimeters or 0.000246 meters. Wherever the decimal point may be placed the percentage of possible error in the measurement is the same, i. e. somewhat less than half of one per cent. in the present instance. Suppose several such measurements to have been taken at the same place on the wire, giving an average of 0.02458 cm. for the most probable value If all the readings had been between 24.0 and 25.0 it is pretty certain that the first two significant figures are correct, but there exists an uncertainty about the next one to the right. In computing the average from several observations it is usual to retain one figure more in the result than the readings give, but the numerical value of that figure is very uncertain. It indicates, roughly, what reliance may be placed upon the value of the preceding figure. If it is numerically less than 5 the preceding figure is the more probable one to use; if greater than 5 the preceding figure is more likely to be 1 too small. Thus in the number given above the preference would be in favor of calling the average .0246 rather than .0245. The wire being circular and of diameter .0246 cm. its sectional area is $\pi d^2/4$ or .0004752· sq. cm. using for π the value 3.1416.

Now, since the diameter may be in error by 1 part in 246, its square is in error by 2 parts in 246 or 1 in 123. The computed area of section will be in error by this same amount no matter how accurate the value of π may be taken. One part in 123 is nearly 4 parts in 475. Hence the third significant figure in the computed area may be considerably wrong. If the 5 in this number cannot be depended upon as being correct then certainly all the figures to the right are wholly unreliable. The result would have been just as accurate to use for π the approximate value 3.14 and to have dropped all the rest. Using this value the area is .0004750.

The length of this wire was measured, we will say, and found to be 266.3 cm.; i. e. it is correct to the nearest millimeter. In other words, this value is not wrong by more than one part in 2663. Multiplying by the area of section gives for the volume .12657 c. cm. Obviously this number is in error just as much as the area was, namely, one part in 123. The first three figures of this number are therefore all that can be relied upon as giving the volume of the wire, although there is some uncertainty about the third.

It thus appears that with this degree of approximation in the value of the cross section, it was unnecessary to measure the length with so much accuracy as was done. In fact, if the length had been observed to the nearest centimeter, the value would be nearer the truth in per centage of itself than was the cross section. Furthermore, any values between 265 and 267 cm. would have given volumes approximately the same as that found from the actual length. Using 265 and 267 cm., the volumes are respectively .1259 and .1269 cubic centimeters.

This example will serve to illustrate the fact that it is not necessary to go to the trouble of making extremely accurate measurements of certain quantities in an experiment when certain other related ones are only roughly measured. Frequently some of the quantities cannot be measured with the same degree of precision that others can, without expending extra time and labor on them. Quantities which are to be squared require more accurate measurement than those which are not squared, if they enter a formula together. On the other hand, certain quantities which apply as corrections to other quantities, and are themselves quite small, need to be known only roughly. Thus in correcting the weight of a body for buoyancy of the air, if the temperature of the air is known within a few degrees it is generally sufficient.

Very small, as well as very large, magnitudes in general are difficult of close measurement and the numerical values of such can be found only roughly by direct observation upon them. Yet it is not unusual to see the results of experiments expressed by numbers containing a half dozen or more significant figures calculated on the basis of measurements which could not have approximated to the truth nearer than one part in 100. It is safe to say in general that the accuracy of the result of an experiment which depends upon the measurement of several quantities, will be determined mainly by the accuracy of that one of the principal measurements which is the lowest of all. It is with great difficulty that a degree of accuracy greater than one part in 50000 can be reached in the value of a quantity requiring indirect measurement. For most practical purposes an accuracy to one in a thousand is close enough and may not be very hard to attain in a particular instance. But if it is desired to know the true value of the next significant figure of the result accurately the difficulty of getting it is greatly increased. The true value of an observed quantity correct to six significant figures requires for its determination in the majority of cases the most skilled observers, sensitive apparatus and the most refined methods of experimentation. Computed values ought not, therefore, to show more significant figures than are warranted by the accuracy of the measurements. All unnecessary ones should be dropped and the number filled out with 0's to indicate how near to the truth the value has been found.

ALUMNI

Notes on Lead-Silver Mines ... and Smelting Works.

By Max B. Fitch, '90, Graphic Smelting Works.

PART II. CONCLUSION.

CONDITIONS FOR SMELTING ORES.

THERE are some essentials for successful work in reducing ores by smelting. There must be an ample water supply for making steam and cooling the water jackets of the furnace. In an arid country, this is often difficult to secure. It was obtained here by sinking a well in the bottom of the valley, some nine thousand feet away from the mines. The well was sunk through sand, gravel and boulders, one hundred and fifty-five feet to the bed-rock, and then tunnels were run from the bottom crosswise of the valley, both to intercept the flow and to increase the storage capacity of the well. The supply is entirely from the underflow and represents the drainage of about eight square miles. During the last two weeks of work on the well, over fifty thousand gallons were pumped daily to permit the work to proceed. The well is equipped with a Cameron deep well pump with a ten by thirty-six steam cylinder at the surface and a five and one-half inch working barrel near the bottom of the well. This pump delivers three thousand gallons an hour with an average of one hundred and fifty feet lift through twenty-two hundred feet of four-inch pipe into a reservoir located twenty-five feet above the top of the jackets in the furnace, and holding eighty thousand gallons. The water is so pure that in twenty months the furnace boiler has shown no scale, the simple expedient of blowing off twice a day being sufficient to keep it clean. To run the pump at the well ten hours each alternate day gives an ample supply for all uses at the smelting works.

A considerable supply of good limestone is another essential. The belt or zone in which the mines are located furnishes this in unlimited quantity and of excellent quality. What silica it contains is segregated into kidneys of chert, which are readily separated in quarrying, so that the resulting product rarely contains over three or four per cent. of silica and only a trace of magnesia. The faulting of the strata before described, has thrown this belt of limestone down the mountain, so that the limestone quarry is just below and adjoining the entrance to the mine. It is quarried, sorted and dumped into chutes near the ore bins and from there drawn into the tramway cars for transportation to the smelting works, the total cost delivered being less than seventy cents a ton.

While these lead ores always contain iron, in greater or less quantities intermixed with the ore, it is often not enough to balance the silica contents. Some portions of the mine furnish in great abundance a very good red hematite averaging sixty per cent. metallic iron which provides for this need. Other portions of the mine produce iron pyrites to furnish the small quantity of sulphur that is needed in the furnace.

All the materials absolutely necessary to conduct this smelting proposition are obtained on the ground except the coke and steam fuel, which must be brought by the railway at considerable cost. The materials in hand, however, comprise eighty-five per cent. of the tonnage handled, and their assembly at a low cost makes it possible to successfully conduct a smelting proposition on ores so low in grade. It is probably quite a rare occurrence that one property shall contain so many essential conditions within its own borders.

The Graphic Smelting Plant is located on an ore branch of the Santa Fe Railway, two miles south of Magdalena and on a line between the mines and the well. The location is made on sloping ground, favorable to the handling by gravity of everything coming from the mines, the only materials elevated being the coke and the slag returned to the furnace.

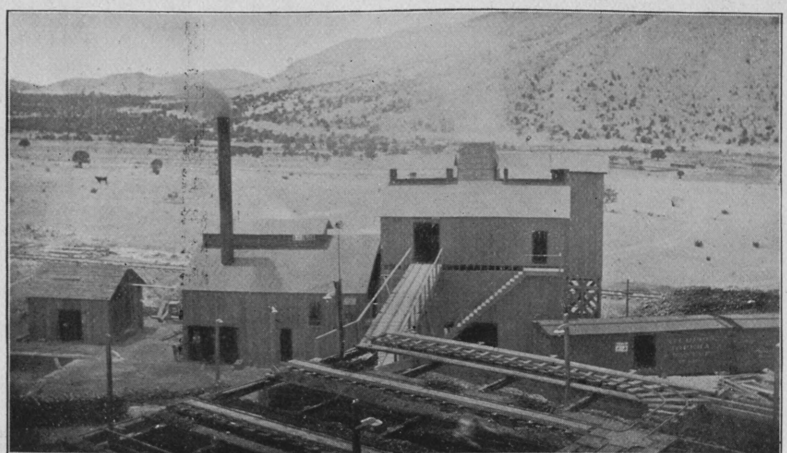
The plant consists of a sampling works and storage bins for ores on the same level as the upper or feed floor of the furnace; of the furnace building, which contains the furnace and elevator; of the power house, which contains the boiler, engines, blower, pumps and dynamo; of a smithy, a store house for supplies and of the office building containing the assay furnace, laboratory and business office.

Besides these, there is a storage reservoir for water before mentioned, and a small reservoir receiving the hot water overflow from the jackets, from which it is lifted by a pump into the storage reservoir to be cooled and used over again.

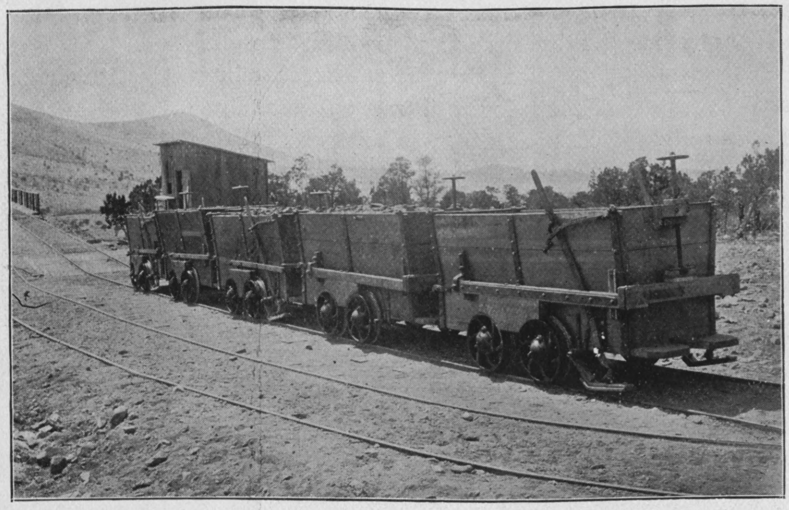
In the storage bins, which have a capacity of about fifteen hundred tons, the ores are made into "beds" by spreading each "lot," of from twenty to two hundred tons, evenly over the surface of the bin, so that when the ore charges are taken out of the bed for use, a fair average mixture of all the lots in it is obtained, from the beginning to the end of the bed, and the metallurgist has then a fair idea of the contents and character of the ore he is using.

Careful determinations of everything going into the furnace are essential to successful work, for the ores of one mine even vary in the different stopes and from day to day in the same stope.

The trains of ore and limestone stop at the



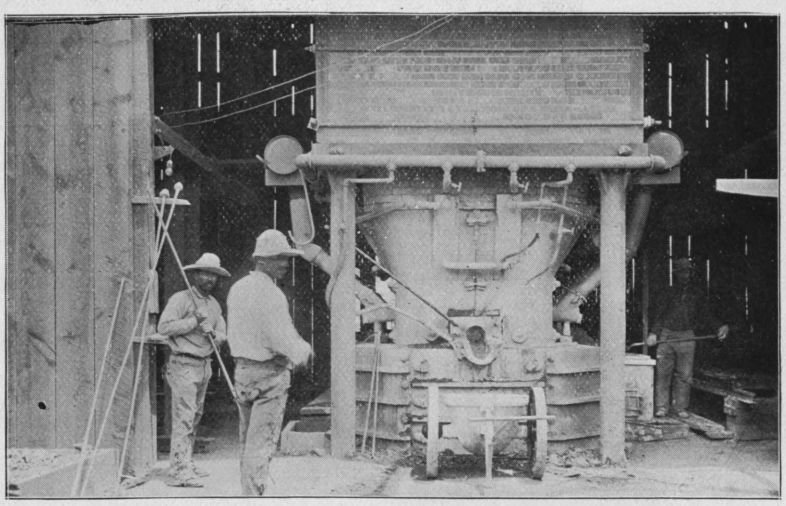
THE GRAPHIC SMELTING WORKS. View from top of trestle looking down on the ore beds. The pump house is just at the left of the top of furnace, in the distance.



Showing improvement in wheel brakes, by changing form of brake shoes, which are made from 3″ native pine planks. The rear car is the latest—with oak bars substituted for iron, and brake shoes longer and not so deep.

weighing station, about five hundred feet from the furnace. There the cars are uncoupled, weighed and the weight recorded. A sample is taken from which the moisture in the ore is determined. The cars are then run out on a trestle three hundred feet long, at the end of which are hopper bins, one for the limestone and another for the ore. The ore bin discharges on a platform covered with steel plate that is on a level with the mouth of a nine by fifteen ore breaker of the Blake type, and two men readily feed from seventy-five to eighty-five tons of ore into the breaker in ten hours' work. The lumps in the ore are broken to about three inches for the larger sizes and the ore is received into a car placed under the breaker. When filled the loaded car is replaced by an empty one and the load is run out on tracks laid over the bins where the beds are made and dumped into the bin then being filled, so as to make an even layer of that lot of ore all over the surface of the bed. One man does the work of receiving the ore from the breaker and dumping it in the beds.

While feeding the breaker the shovellers put aside every twentieth, tenth or fifth shovelful, according to the richness of the ore, for a sample. When a sufficient portion of the sample has accumulated, the car is removed from under the breaker and the sample is run, falling through a chute to the floor of the sampling works below. The sample is then run through a smaller breaker of the same type, and coned and quartered in the usual manner, until a wheelbarrow load remaining will represent perhaps a hundred tons of ore. This wheelbarrow load is then taken to the "grinder," (something like a big coffee mill), which reduces it to about the size of ground coffee and also divides it into two equal portions. One of these portions is coned and quartered until the quantity is reduced to three or four pounds, which is ground with a muller on a bucking board (a slab of iron planed smooth) to a pulp



The Graphic Smelting Works. The "Front" of Furnace. Lead wells and molds are on the right and a stack of bullion is dimly seen in right far corner. Taken between taps of slag, which average every three to five minutes.

that will *all* pass through an eighty mesh sieve. The finished sample is divided into two or more equal parts, which are put into paper bags, sealed and properly labeled. One of these the sampler keeps for future reference, one is sent to the assay office for determination, and if the ore has been purchased, one is sent to the seller. The sampler, with occasional help from a laborer, makes up these samples, together with the daily samples of slag and hand samples from the mine, and also cares for the engine that drives the sampling works.

Each bed is made up of from two to four or more lots of ore, and the sample of each lot is assayed separately for lead, silver, gold, zinc and copper. A bed sample is then made up from the samples of the lots composing it, in their respective proportions by weight to the weight of the entire bed. An analysis of this sample is made for iron, silica and lime. From the data thus obtained, by assay and analysis, the charges for the furnace are figured. Occasional determinations are also made of the coke and limestone. The combinations made are checked by the assay of two regular daily samples of the slag obtained, from which are also determined how much lead and silver is not recovered from the ores.

When a new bed of ore is to be used, a "charge card" for it is made out and tacked up at the charge scale, and by it the weigher and his two helpers make up the charges in iron dump-cars, putting in them the stipulated amount by weight of each kind of ore, limestone, etc. A recent charge card is as follows:

	Wt. of Charge.	Wt. of Car & Charge.	
Bed No. 138	1050 lbs.	1650 lbs.	
Commercial Ore No. 16	30	1680	Coke 235 lbs.
Iron Sulphate	25	1705	
Iron Ore	40	1745	Wood 40 lbs.
Limestone	315	2050	

Ore bins at the mines and upper end of tramway. Limestone bins in the foreground at the right.

Each car load is a charge. Four charges are made ready to be delivered when required. While the ore charges are being prepared, the coke and slag man brings the required amount of coke up on the elevator in a car and dumps it on each side of the furnace. The feeder and his helper then charge the coke into the furnace, spreading it over the top of the previous charge, with the sticks of cord wood distributed on top of it. Then the weigher's helpers deliver the four ore charges and dump them on the plates, two charges on each side of the furnace. The feeders then charge the ore, spreading it evenly over the coke and wood, using coke forks and taking the coarse ore first, and afterwards taking the fine ore that remains with shovels and spreading it over the portions that most need to be packed tighter against the blast.

A considerable portion of slag, amounting to between seven and nine tons a day, is charged back into the furnace. This is not always done on account of the values it may contain, but because it fuses easier than the ore, and tends to promote the smelting. It is not weighed but fed as directed, so many shovels full to a charge. For this purpose a stock is kept on the feed floor out of the way of other work. The coke man also loads and brings up on the elevator the supply of slag.

The furnace is forty-two by one hundred and twenty inches at the tuyeres, and it is eighteen feet from the tuyeres to the charge floor. Its estimated capacity is one hundred tons daily, counting ores, limestone and slag. In one year's run it averaged somewhat over one hundred and five tons daily.

One feature in the construction of the furnace which is worthy of note is the absence of flue dust chambers, and the continuation of the stack with the same inside dimensions for a height of eighteen feet above the feed floor. Five feet higher it is drawn in twelve inches all around. On account of the height of the furnace charge, there is very little flue dust, and the ores being of so low a grade the saving would not pay the interest on the amount necessary to construct and operate the dust chambers.

On the first year's work cast iron water jackets were used, but these showed such a tendency to destruction by cracking, that steel plate jackets were substituted for the sides, and will probably be used for the ends also. They do not crack, and if a hole should be burned in one, it could be patched. It seems impossible to mend even a small crack in a cast iron jacket.

The water jackets are fed by branches from a three inch pipe line, bringing water by gravity from the main reservoir.

The hot water overflow from the jackets is pumped back into this reservoir, and it would sometimes happen that the whole supply would get pretty warm. It was thought that perhaps the hot feed water had something to do with the cracking of the cast iron jackets, and a cooler was built to cool the hot water before returning it to the main reservoir. This was simply an open frame work, in which a three inch stream of hot water was distributed by troughs, so that it fell over a succession of narrow boards until it was broken into drops before it reached the reservoir. The dry air circulating freely through this shower of streams and drops, caused considerable evaporation and cooled the water to about its own temperature.

It was a great success as a cooler, and the feed water was served to the jackets at a very even and much lower temperature, but that did not stop the cracking of the cast iron jackets.

The slag is drawn from the furnace at intervals into pots holding about eight hundred pounds. The furnace, in twenty-four hours, averages about one hundred and ninety pots of slag, which are drawn to the end of the dump by a horse cart.

The charges for the furnace are figured to produce a slag of a definite composition. The metallurgist assumes a slag composition which, for that ore mixture, will produce the best results. When the charge is down, and the furnace commences running slag from that charge, a special slag sample is usually taken. This is done by dipping an iron rod into the molten slag in the pot and immediately immersing it in a vessel filled with water. Slag suddenly chilled is much easier dissolved for analysis work than if allowed to cool slowly. The resulting analysis seldom shows exactly the composition figured for it, but the silica and iron do not usually vary from the figured composition more than one-half of one per cent. The charge above tabulated was figured to produce a slag of the following composition:

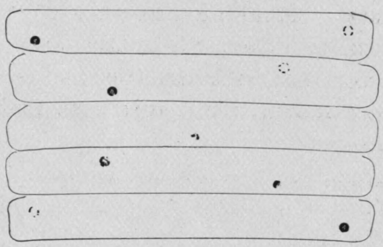
$$\begin{aligned} SiO_2 &= 30.0 \\ FeO &= 32.5 \\ CaO &= \underline{18.5} \\ & 81.0 \end{aligned}$$

There are conditions continually arising which make it desirable to change the above proportion. Ores running high in zinc are troublesome. The zinc, being quite volatile, forms heavy accretions on the walls of the furnace. The object is to carry as much as possible into the slag, and the furnace has at times produced a slag carrying thirteen per cent. zinc oxide.

With a furnace making no matte, from one and one-half to two per cent. copper gives trouble in the crucible, forming accretions in the bottom which have a tendency to stop up connection with the lead well, and often necessitates what is sometimes termed "Muscular Metallurgy." Most of the copper is worked into the bullion as copper dross.

The lead well is in the center of one side of the furnace and is the usual siphon tap. The lead runs intermittently from the well into a cooler, which holds about thirteen hundred pounds. From the cooler it is dipped into moulds, producing pigs or bars weighing about one hundred and eight pounds each.

In sampling the bullion five bars are sampled at a time, each bar is punched as shown in diagram below, and a core taken out ⅛ inch in diameter, and half the thickness of the bars. The five bars are then turned over and similar samples taken, but in an opposite direction.



The sample of a car-load of bullion (twenty-one tons) will weigh about three and one-half pounds. This sample is then taken to the assay office, melted into a small bar and assayed for gold and silver.

The blast is furnished by a No. 7 Connersville blower, running at one hundred and forty revolutions per minute. The pressure varies with the "tightness" of the furnace charge. The best results are had when this is such as to make the pressure, at this speed, from one and one-half to one and three-quarter pounds to the square inch.

This is perhaps the best ventilated plant in the whole country. To this end the natural conditions were favorable and they are taken advantage of. This is important, for men cannot do good work in heavy fumes that, after a time, are sure to bring sickness.

In the arrangement of the plant, from beginning to end, great consideration was given to its economical operation. Where men were indispensible they were given an opportunity to do their work to the best advantage. One instance of this is the system of tracks and car service everywhere. This excellent arrangement is largely due to Mr. T. S. Austin, M. E., who designed the plant.

That it has done good work is shown by the fact that in the five hundred and forty-seven days the furnace has been in blast, it has reduced over forty thousand tons of ores, nearly all of which came from the Graphic Mines, and yielded a product of forty-one hundred and fifty tons of lead and eighty-nine thousand ounces of silver, from material so low in grade, that skillful work and economy are indispensible.

ALUMNI NOTES.

The Technic extends its most hearty congratulations to Mr. and Mrs. W. H. Palmer upon the birth of a daughter January 14; and also to Mr. and Mrs. T. L. Condron upon the birth of a son, January 22.

S. S. Frank, '92, has a position on the engineering staff of the Western Electric Co., Chicago.

T. D. Jones, '89, is resident engineer for the Canon City and Cripple Creek Electric Railway Co.

F. G. Hunt, '96, is assistant cashier for Fleishman & Co., at Cincinnati.

WANTED—Copy of The Technic for October, '91, I:1: June '95, IV:9; and December, '93, III:3.—Business Manager.

Basket Ball.

A schedule has been arranged for a series of basket ball games to be played between the four classes during the winter months.

Two games are played each Saturday, the first half of the second game taking place between the halves of the first-called game. This gives the men a longer time to rest up, as well as serving to keep the ball moving continuously. The time of each half is twenty minutes.

The men to officiate at these games are:

McCormick, Referee.	McMeans, Umpire.
Howell, Scorer.	Shepard, Time Keeper.

THE SCHEDULE.

Jan. 22,	Senior–Fresh.	—Junior–Soph.
Jan. 29,	Senior–Junior.	—Soph.–Fresh.
Feb. 5,	Senior–Soph.	—Junior–Fresh.
Feb. 12,	Junior–Soph.	—Senior–Fresh.
Feb. 19,	Soph.–Fresh.	—Senior–Junior.
Feb. 26,	Junior–Fresh.	—Senior–Soph.

The first game of this set was started at three o'clock on the date set, when at the sound of the referee's whistle the ball was set rolling, and the hard work of determining the school championship had begun.

The men started out with too much dash, and much needless exertion was spent chasing the ball to and fro. All goal throwing was wild, and no genuine playing occurred until, out of necessity, a slower pace was set, when the ball was passed more and several pretty goals were thrown.

The Seniors were at a decided advantage throughout, and kept the ball in the Freshman territory most of the time. Whether this was due to better material or simply to the fact that '01 lacks experience, is a question which will take several games to decide.

A few good plays were made during the game, but too much batting of the ball occurred for good results. Dickerson threw a goal from center of the field while still on the run. Hadley did well for the Freshmen, whereas Ryder and Freudenreich showed up most prominently for the Seniors.

	GOALS.		FOUL.
SENIORS.	From field.	From foul.	
Kidder	2	..	..
Ryder	5	..	1
Freudenreich	3	3	..
Austin	..	..	2
Ford	..	..	2
FRESHMEN.			
Lyon / Weatherhead	..	..	1
Hadley	1	2	1
Wilbanks	..	1	3
Dickerson	1	..	1
Kittredge	..	..	..

Score: Seniors, 23; Freshmen. 7.

The second game for this date was played between '99 and '00, and showed a one-sidedness equal to that of the first game. This was the second time this year that these two teams met; and although much more skill was shown in throwing goals on both sides, still '00 lacked the team work to make her plays effective.

The Sophs. were not as watchful of their men as they should have been, and '99 had many open chances for goal. The Juniors also displayed considerable skill in passing the ball, and were thus enabled to play with greater ease. '00 does not play the game it did last year and the loss of Huthsteiner and Hegarty is felt to no small degree. The best work was done by Pflegíng and S. Kidder for the Sophs., while A. Kidder and McLellan did best for the Juniors.

	GOALS.		FOUL.
JUNIORS.	From field.	From foul.	
Kidder	5	..	1
Stone	1	..	..
Jumper	3	1	..
McLellan	1	..	..
Davis	..	..	..
SOPHS.			
Pfleging	1	..	..
Maier	1	..	1
Kidder	2	..	..
Madison	..	..	1
Appleton	..	..	..

Score: Juniors, 21; Sophs.. 8.

THE second set of games of the basket ball series was played on Saturday, Jan. 29, the Seniors opposing the Juniors in the first-called game. These two teams are well known to have the best chances for the championship and every man on the respective teams set out with the greatest determination to win, so that the spectators were entertained with a closely contested and hard fought game. During the first half the ball was kept moving at quite a lively rate and chances were equal for goals on either side. Very few free throws were obtained, however, and these were all unsuccessful until Davis, catching the ball past the center of the floor, took good aim and landed a pretty goal. A good many fouls were called on either side and at the end of the first half the score stood at 4 to 3 in '99's favor.

In the second half '98 did better work and succeeded in making several well directed passes, keeping the ball out of '99's possession, while the ball was passed from one free man to the next, gradually approaching the goal. One of these passes resulted in a goal thrown by Ryder. At one point of this half a violent scrimmage took place, in which men went at the ball as in a foot ball game, and although the umpire's whistle repeatedly blew for fouls, it was only after some moments that the men picked themselves up from their scattered positions on the floor and regained their composure.

Stone then threw an easy goal from under the basket and MeLellan threw a pretty goal from the center of the field. Freudenreich threw quite a number of goals on fouls, and the game was within one minute of being over, with the score 8 to 8, when Austin made a splendid throw from past the center of the field, dropping the ball squarely into the basket, turning the game in '98's favor with the score 10 to 8. The score is as follows:

	GOALS.		FOULS.
SENIORS.	From field.	From foul.	
Kidder	..	..	..
Ford }	..	..	2
Ryder }	1	..	..
Freudenreich	..	6	2
Hubbell	..	..	3
Austin	1	..	3
JUNIORS.			
Kidder	..	..	2
Stone	1	..	4
Jumper	..	2	3
McLellan	1	..	1
Davis	1	..	1

Score: Seniors, 10; Juniors, 8.

The second game on Jan. 29, between the Sophomores and Freshmen, was also very close and interesting. '01 did remarkably well considering their inexperience in playing, but still they batted the ball around entirely too much and made too few passes. Their individual work was what made the score.

The Sophomores played more steadily and used better judgment in passing the ball and, taking everything into consideration, their team work was very creditable. Some individual work on their side also showed very prominently.

Sophomores.	Goals. From field.	From foul.	Fouls.
Maier	1	..	1
Kidder	1	..	1
Pfleging	1	4	..
Madison	..	..	..
Appleton	..	..	2
Freshmen.			
Clay	1	..	1
Lyon	1	..	1
Dickerson	..	..	3
Kittredge	..	..	..
Wilbanks	..	2	2

Score: Sophomores, 10; Freshmen, 6.

THE Senior–Sophomore game of Feb. 5, was played at the allotted time, and resulted in a defeat of '00 with a score of 22 to 3.

The Seniors played easy but steady ball, and did a considerable amount of passing. They kept the ball around the Soph's goal most of the time, so that when the '00 forwards got possession of the ball they were often too far away to make a goal.

A considerable improvement was noticed in the playing of the men over the previous games, and N. Kidder succeeded in making a record of six goals from the field.

Richardson was injured in the first part of the game, and his removal had some effect on the strength of the '00 team.

Seniors.	Goals. From field.	From foul.	Fouls.
N. Kidder	6	..	1
Austin	2	..	1
Freudenreich	3	..	1
Hubbell	..	..	1
Ford	..	..	2
Sophs.			
Pfleging	..	3	1
Maier	..	..	3
Richardson	..	..	..
S. Kidder	..	..	1
Appleton	..	..	1
Madison	..	..	1

Score: Seniors, 22; Sophs., 3.

The Junior–Freshman game of this date was postponed by mutual agreement of the two Captains.

THE Rose basket ball team played its first game on Wednesday, Feb. 2, with the city Y. M. C. A. The night was very cold, probably accounting for the fact that only about twenty-five spectators were in the gallery. The game was called at 8:10 and for ten minutes neither side made any headway. The next ten minutes, however, gave Rose three goals from the field which, against the two goals from fouls thrown by the Y. M. C. A., left the score at the end of the first half at 6 to 2 in R. P. I. favor.

The second half was started at a more rapid gait and this was maintained during the rest of the game.

The team work of R. P. I. was splendid and the ball was handled with telling effect. Quite a number of fouls were made, however, by the men, and out of the whole number made by the Y. M. C. A., none were converted into a goal.

The men all played a fine game, and Rose Tech will be provided with a basket ball team this year that will do her credit anywhere.

Y. M. C. A. Players.	Goal. From field.	From foul.	Foul.
Weinbrecht	..	..	1
Davis	1	..	..
Ault	1	5	1
Heinig	..	..	3
Combs	..	..	..
Leasure	1	..	..
R. P. I.			
Pfleging	3	..	3
A. Kidder	2	..	3
Freudenreich	3	..	7
McLellan	..	..	..
S. Kidder	1	..	1

Score: Y. M. C. A., 11; R. P. I., 18.

Referee, Felver; Umpires, McMeans and Kimmel.

THE MEETING OF THE I. I. A. A.

THE meeting of the delegates to the I. I. A. A was called to order by the President at the Denison House, at Indianapolis, on Friday, Jan. 21, 1898.

Delegates from Hanover, Franklin, I. U., U. of I., Earlham, Normal, DePauw, Wabash and Rose responded at roll call; the gentleman from Purdue, however, came in later, making ten colleges in all represented.

After calling the roll and reading the minutes of the last meeting, a report from the treasurer, Mr. Roller, of DePauw, was read, which showed that the Association had about $33.00 on hand.

Hanover, not having paid her dues in time, was declared to be no longer a member of the Association, but her delegate explained that she had no copy of the constitution and thought that any time before this meeting would do.

This excuse was accepted and she was reinstated by a unanimous vote. As the officers of this Association are not elected each year, but go in rotation from one college to the next, the new officers now took their places. This year Hanover gets the President, Earlham the Vice-President, DePauw Secretary and Wabash Treasurer.

A representative of Notre Dame here presented a request to become a member of the Association and made a speech in which he showed that that University came up to our standard and promised to faithfully conform to our rules.

After some discussion it was decided that it would be well to admit them, and this was done by a unanimous vote. Now came the most radical change that was made during the whole meeting. Earlham presented an amendment to the constitution to the effect that the "State Field Day" be held every year at Indianapolis, and that this meet be conducted by the same delegates that came to the annual meeting each year.

There was much discussion about this move, but as Earlham had evidently been on the ground early and talked it up with the smaller colleges, it was carried by a vote of 8 to 3.

The list of events was then taken up and much reduced, the revised list being as follows: 100, 220, 440 yard runs; ½ and 1 mile runs; standing and running broad jump and running high jump; pole vault; throwing 16 pound hammer and putting 16 pound shot; 120 yard high, and 220 yard low hurdles, and ½, 1 and 5 mile bicycle races. In all making just 16 events.

Tennis being dropped it was recommended that the colleges have a separate tennis tournament, but no steps were taken in that direction.

A committee composed of Roller of DePauw, Denny of Wabash, and Howell of Rose was appointed to have 300 copies of the amended constitution printed and distributed to the local Associations as soon as possible. The date of the next Field Day was not fixed but was left in the hands of the committee and will be announced later. The rules governing the Western Intercollegiate Association were adopted and the meeting then adjourned.

Immediately after adjourning the delegates present, who are to have charge of the next meet, organized and Roller was made chairman and Howell secretary.

A motion was made and carried that after this year the selection of officers of this committee on arrangements be the same as those of the I. I. A. A. Thus all officers go to each college in rotation. A committee on grounds and apparatus was appointed, consisting of Mr. J. Gavin of U. of I., Mr. Denny of Wabash, and Mr. Ewry of Purdue.

It now being quite late and much needing to be done, a meeting of this same body of delegates was called at the same place for the third Saturday in February when the above committee is to report.

The expenses of the delegates and all other expenses incurred by the local Associations for the general Association were to be kept count of and subtracted from the receipts of the general Association, and the remainder, if any, was then to be equally divided among the contesting colleges. Losses, if any, were to be also equally shared.

This meeting now adjourned.

After this there was a meeting of several of the base ball managers, and the following games were scheduled for Rose:

April 23 — DePauw at Greencastle.
" 30 — Normal.
May 7 — Wabash at Terre Haute.
" 14 — I. U at Bloomington.
" 21 — Normal.
" 28 — DePauw at Terre Haute.

It is hoped that Rose may be able to get a game with Notre Dame or Purdue, and if proper support is received from the students at the home games, an attempt will be made to get one of the above to play here in June.

CECIL A. HOWELL.

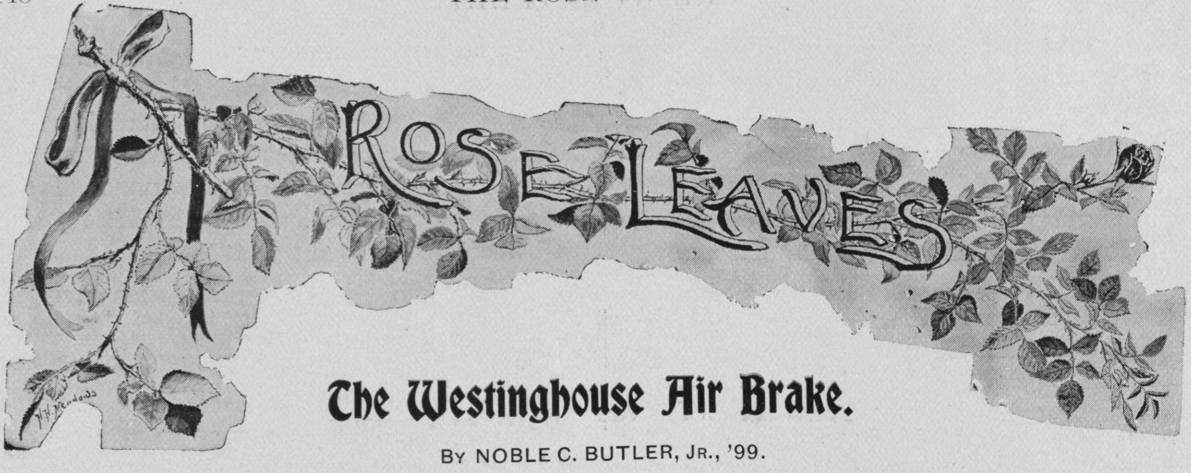
NOTES.

Regular gymnasium work is now being taken by the Freshman and Sophomore classes, each putting in one hour a week under the direction of Instructor McMeans.

A meeting of the Athletic Directors was held on Monday, Jan. 23, in Dr. Mees' office, all members being present. Mr. Howell's report of the delegates of the I. I. A. A. at Indianapolis was heard. Mr. Howell was then chosen as delegate for Rose to the committee meetings in which Rose is represented, to make arrangements for the coming Field Day, which will be held in Indianapolis this spring. Mr. Howell also made a report of the schedule that had been arranged for the coming base ball season. The election of a manager for the foot ball team of next season was postponed indefinitely.

The series of basket ball games, that is now being played between the classes, offer many opportunities for the display of class spirit. The games are quite interesting and exciting and are worthy of much better support than they have thus far received, there being no reason why the gallery should not be crowded with spectators. The teams are far from being supported in a deserving manner. A bit of encouragement in the way of a word from the gallery often produces wonderful results and could, in some cases, be the cause of the winning of a close game. For instance, during the game with the Y. M. C. A. the Rose men slowed up at one time and were being out played, when a few words of encouragement from the gallery turned the tide of affairs so that two goals were thrown in rapid succession by Rose, after which the playing was kept up to a quicker pace. All men cannot play on the class teams, but much aid could be given if all would get out and "root."

A revision of the foot ball rules has been proposed by a committee appointed by the conference of the western colleges, wherein several changes have been considered. The intentions are to free the game of some of its rough points as well as to make some changes in the method of scoring. It is intended to rule out all mass plays as well as foul playing in the line up, no man being allowed to touch the other side until the ball is in play. The proposed rule for scoring is to count a goal attained by touch down, 5; goal from field kick, 4; goal from place kick, 3; touch down failing goal, 4; safety by opponents, 2. These changes as well as a few others of minor importance, have not been received with much enthusiasm by the foot ball men, although they admit the method of scoring to be an improvement on the old one. In the east a similar movement is on foot and on Feb. 12th a body of representatives of the different eastern colleges will meet at New York to change the rules so that there will be fewer fatalities than occurred last year on the gridiron, thus putting a stop to all public criticism regarding the brutalities of the game.



The Westinghouse Air Brake.

By NOBLE C. BUTLER, Jr., '99.

THE commercial or practical value of an invention is measured by the saving it effects in labor and its facility for affording comfort and safety to that portion of humanity which comes directly or indirectly into contact with it. In respect to these points, the Westinghouse Air Brake is certainly one of the greatest productions of the century.

The history of train stoppage by compressed air is brief but shows a steady and rapid growth. It would be difficult to say exactly who was the originator of the scheme, because no matter what railroad shop you enter, there will be pointed out to you the man, or the son of the man, to whom the right of discovery really belongs. However, Mr. George Westinghouse, Jr., applied for a patent in 1873, and his being the first application of that kind, he was nominated originator of his ideas and was granted the right to all profits which might arise therefrom.

Up to that time there were several men who had plans worked out to a degree of precision and nicety almost equal to the system of this day, except that they began at the brake shoes and worked backwards, drawing their supply of air from the first source that occurred to them, which was, unhappily, not the best one.

It is well known that if an engine be running forward and the reverse-lever be thrown two or three notches back of center, or *vice versa*, the cylinders will pump air back towards the boiler. The men at the time referred to utilized this principle in their calculations, and provided a reservoir in the front part of the engine, usually on the pilot, which was suitably arranged with check valves to receive the air so pumped. Then, by a three-way cock, they could send the air into the brake cylinders, set the brakes, and then exhaust it all into the atmosphere and release.

The only trouble with this system was that it would not stop the trains. You can readily see that the engine would have to run faster than usual before making an application of the brakes and even then the supply of air was not to be relied upon. The stopping of the train was due to the reversal of the engine more than anything else.

After a while an air pump was put on the engine and this supplied the air to a main reservoir from which it could be sent through the train pipe to the cylinders and thence to the atmosphere by means of a three way cock. This scheme was the first one patented and was known as the "Straight Air" system. It was used for some time, more especially for making stops at terminal stations, hand brakes being deemed most efficient for station stops, because, at times, the pump would not work unless assisted by the engineer's hammer. Thus the supply of air was an uncertain quantity and oftentimes after making a stop there was not enough air left in the leaky train pipes and reservoir to assist the springs in releasing the brake shoes from the wheels.

Upon daily use the drawbacks of this system were noticed and as the ideas of railroad operators advanced, just in the same ratio did this brake become unpopular.

In using the three-way cock, there was no way to equalize the pressure between the train pipe and brake cylinders during applications and the engineer was entirely dependent upon his judgment, consequently the stops were very severe at times.

It was not a great while until a marked improvement was made in the form of the triple valve. Then followed in rapid succession engineers' brake valves, automatic triples, etc., each embodying the original principle but making the action more nearly automatic, until the system that is now in use was brought out.

An air brake system is a composition of ten elements so connected that they act in perfect harmony to produce the effect.

1. There is a steam air compressor usually hung on the right side of the engine which takes steam from the boiler of the locomotive. The steam and air cyclinders are each 9½ inches in diameter with a 10¼ inch stroke and can raise the pressure in the main reservoir from 0 to 90 pounds in about 80 seconds.

2. The main reservoir into which compressed air is pumped at 90 lbs. is usually hung under the frame of the engine. The air contained in it is used in releasing and not in setting the brakes. In passenger service the capacity shall not be less than 16,000 cu. in. and in freight 24,000 cu. in.

3. The engineer's equalizing discharge valve, located in the cab, regulates the flow of air from the main reservoir into the train pipe for releasing and from the train pipe into the atmosphere for applying the brakes.

4. The train pipe leads from the main reservoir to the engineer's valve, thence along under all the cars, supplying air to the apparatus under each car.

5. The auxiliary reservoir, located under each car, stores a certain amount of air for use on that car.

6. The brake cylinder, fitted with a piston and piston-rod, is hung under each car and so connected to the leverage under that car that when the piston is pushed out the brakes are applied.

7. The quick action triple valve would better be named "quadruple," because it performs four operations. It is located under the car and is so connected with the train pipe, auxiliary reservoir, and brake cylinder that it can admit air from the train pipe to the auxiliary reservoir, from the auxiliary to the brake cylinder, thence to the atmosphere, and it can also permit air to pass from the train pipes to the brake cylinder at the same time. The triple is entirely automatic in its action and is governed by variations of pressure in the train pipes.

8. The couplings, which connect the train pipe between the cars, are fastened to a flexible hose having somewhat of a sag. If a train breaks in two, this hose coupling becomes horizontal but cannot remain fastened in that position, so an emergency application of the brakes is made.

9. The duplex gauge, located in the cab, is provided with a red and black hand showing simultaneously the main reservoir and train pipe pressures.

10. The pump governor, located near the pump, automatically controls the supply of steam to the pump, starting or stopping it according as the pressure on the main reservoir is too low or too high.

Of these ten parts the engineer's brake (Fig. 1) and the triple valve (Fig. 2) are of the most importance, and if their workings are properly understood, the matter of stopping is very much simplified.

Be it understood that connections are made as indicated and that the train pipe leading from the lower end of engineer's valve is connected to the triple at 1.

As the drawings now stand the brakes are in full release. Air comes from the main reservoir through ports 22, 21 and 19, Fig. 1, thence through the train pipe and ports 1, 2, 3, 3, 4 Fig. 2, forcing piston 6 as far to the left as it will go, then a small amount of air leaks around piston 6

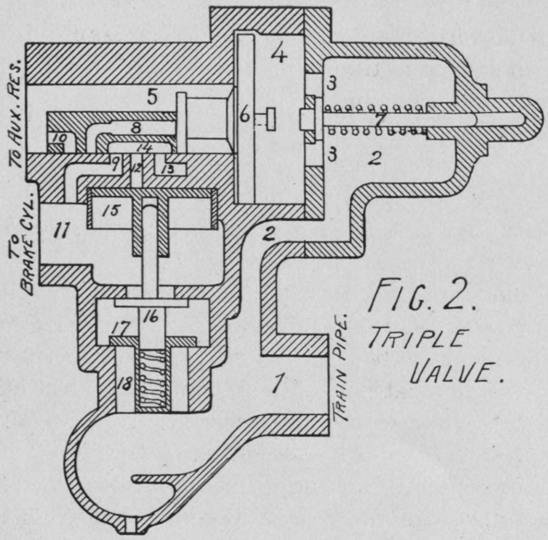


FIG. 2.
TRIPLE VALVE.

through leakage groove and chamber 5, charging the main reservoir under each car. Whatever air was in the brake-cylinder can now pass through ports 11, 9, 14 and 13 and escape to the atmosphere. At the same time in Fig. 1, some air has gone through ports 22, 21, 27, 28 into chamber 31, forcing piston 32 to its lowest position and through 33 to storage cylinder under the running board of the engine. This draft on the main reservoir has reduced its pressure so the pump starts up and pumps until stopped by the governor at 90 pounds. Now turning the brake handle to what is called "running position," which is the position used between stations, direct communication between 22 and 19 (Fig. 1) is cut off. Air now passes through 22, 26, 29, pushing feed valve 38 from its seat, then through 30 to 19. The spring within feed valve has a resistance of 20 pounds, so if the main reservoir pressure be maintained at 90 pounds the train pipe will be kept at 70 pounds and will keep train pipe pressure at 70 pounds regardless of leaks. Now air has been allowed to flow into 19, it can go around through 27, 28, 31 and 33 as before, keeping the equalizing drum charged to train pipe pressure. To make a gentle or "service" application of the brakes, the brake valve is moved first to "lap" position. Now all ports are closed and no air can flow either way. By moving to the "service" position air can flow from chamber 31 through 26 and 25 to the atmosphere, reducing pressure on upper side of 32, when it rises and opens valve in 34, allowing train pipe pressure to exhaust to atmosphere. When the pressure in 19 is reduced to that of 31, the piston 32 will again seat itself. After making a reduction of about 6 or 8 pounds the valve is returned to "lap." Now a reduction of pressure in train pipe has caused the pressure in 1, 2, 3, and 4 (Fig. 2) to become lower than that of 5. Hence piston 6 moves to the right until stopped by graduating spring 7 and in this position air passes from 5, through 8. 9, 11 to brake cylinder pushing its piston out and partially setting the brakes. By making two or three applications in this way the pressures in the equalizing drum and 31 (Fig. 1) train pipe and brake cylinders are the same and may be kept so until the train pipe pressure has been reduced 20 pounds, put-

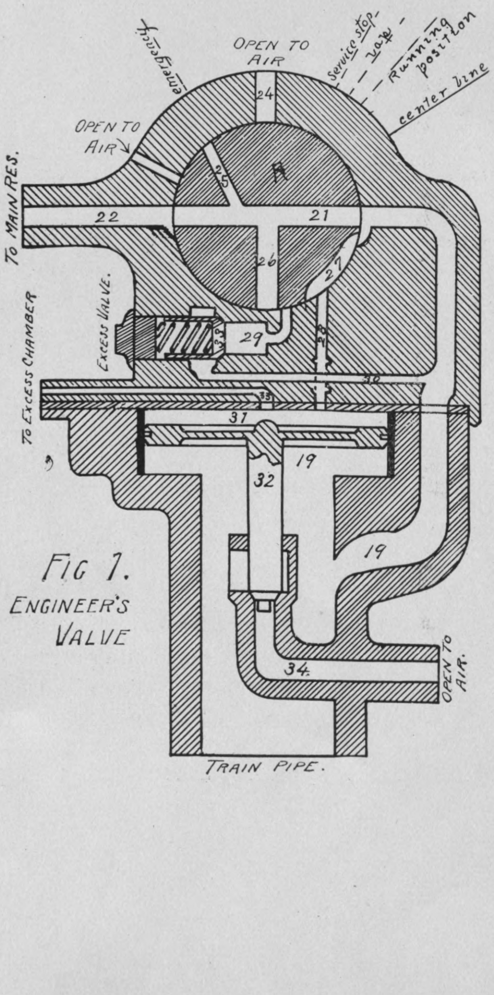


FIG 1.
ENGINEER'S VALVE

ting 50 pounds into the brake cylinders. In making quick stop in case of danger, to get full braking force the brake valve is put in "emergency" position. Now the train pipe pressure can flow through 19, 26, 21 and 24 (Fig. 1) to the atmosphere without moving piston 32. In reducing the train pressure so rapidly the resistance in 4 and 3 (Fig. 2) has become so little that piston 6 rushes to the right and its inertia compresses spring 7. In this position port 10 is opposite 9, allowing auxiliary reservoir pressure to pass into brake cylinder. At the same time some air passing through 5, 8, and 12 forces 15 down and moving valve 16 from its seat the pressure in chamber 17 is thereby reduced, and check valve 18 rises allowing the remaining pressure in train pipe to pass to the brake cylinder. In this way an additional 10 or 12 pounds of air is obtained in the brake cylinder, making 60 pounds per square inch on piston or an increase of 20% braking force. The brakes in both cases are released, as shown by the excess of pressure from main reservoir forcing piston 6 to the left, allowing air to escape to the atmosphere where springs in the brake cylinders pull the shoes away from the wheels.

The action above described is practically instantaneous throughout the train when the number of cars does not exceed fifty. The triple valve described is the one used on passenger and freight cars. The one used on engines and tenders has not the ports 15, 16, 17 and 18, hence the pressure in those brake cylinders at no time exceeds 50 pounds per square inch.

There is a T in the train pipe under each car and from this a pipe leads up through the coach on which there is a conductor's valve. It is a straight way cock located in the end of the car and opened by a cord that runs along the side of the car over the windows. By pulling this cord at any point in the train the air in train pipe is all drawn out, thus the conductor can stop the train when the engineer find hsimself unable to do so.

On cars used in hilly country the exhaust from port 13 of the triple valve passes through a "pressure retaining valve." This is a casting containing an iron weight seated over a port of such dimensions that it requires a pressure of 15 pounds to raise the weight and allow the air to escape to atmosphere. Thus, on long grades, brakes may be released, allowing auxiliaries to be recharged, but the retaining valve holds a pressure of 15 pounds in brake cylinders, which keeps the shoes on wheels and the train is under perfect control at all times.

There are certain rules for computing braking force which must be adhered to. Practically, if a brake force be applied to the wheels equal to the weight that is pressing them against the rail it will equalize their adhesion, but at a low rate of speed the wheels will be apt to slide.

Consequently in computing braking force for passenger cars, the force of the shoes at the wheels is taken at 90% of the weight of the car on the track under the wheels on which the brakes operate. As a further safety in freight service this force at the wheels is only 70% of the light weight of the car, thus reducing liability of "slid" wheels to a minimum.

The expression "weight of the car on track under the wheels on which brakes operate," means simply this: If a passenger car weighing 72,000 pounds be mounted on two six-wheel trucks, the weight will be equally distributed on 12 wheels at a rate of 6,000 pounds per wheel. Now if brakes are applied to only 8 of these wheels the braking force required must be taken not as 90% of 12,000 pounds, but as 90% of 48,000 pounds or 43,200 pounds, which will be 5,400 pounds at each wheel. It has been observed that upon a reduction of pressure in the train pipe the triple valve permits air to pass from the auxiliary reservoir to the brake cylinder and exert its force in the piston. The force on this piston rod is computed on a basis of 60 lbs. per sq. in. or the maximum pressure obtainable.

Cars are divided into four classes, according to their weights, and consequently there are four sizes of brake cylinders and hence different pressure on the piston rods.

WEIGHT OF CAR.	CYLINDER.	FORCE OF PISTON.
30,000 Pounds	8″	3,000 Pounds.
30,000 to 50,000 "	10″	4,700 "
50,000 to 70,000 "	12″	6,800 "
70,000 — "	14″	9,200 "

These cylinders are 12″ long and are most efficient when the piston travels 6″ or 7″ in applying brakes. Greater travel is a loss of braking force and less results in "slid" wheels.

It is of the utmost importance, therefore, that the levers and brake gear be kept tight and perfectly rigid. Iron beams are recommended and all pins should have finished surfaces of large area.

In applying brakes to engine drivers every precaution is taken to prevent "slid" wheels. The wheels under cars may be slid without any very serious results, but the weight on drivers is so great that even any small amount of sliding produces flat places on the tires; then the engine has to go to the shop, thus reducing her mileage and incurring expense.

Hence the basis taken for computing the force at the shoes for engine driver brakes is only 50 pounds per square inch, that being the greatest pressure ever reached in the cylinders of engines and tenders. The braking force is exceedingly low, being only from 60 to 70 % of the weight on drivers. The cylinders rarely exceed 12″ diameter, giving a thrust of 5600 pounds on piston rod.

Now that high speed has become an essential feature on several roads, greater braking force is necessary, and the Westinghouse Company has bought out the High Speed Brake. In this system shoes are applied to every wheel on the train, including the pony truck of the engine.

A pressure of about 125 pounds is maintained in the main reservoir and 110 pounds in the auxiliary and train pipe. At high rates of speed the force required to resist turning at the rim of the wheels is necessarily greater than at slow speeds. The pressure on the brake pistons in first application is about 85 pounds per square inch, thus increasing the initial braking force from 90 per cent. to 125 per cent. of the weight of the car. As the speed of the train is diminished the automatic reducing valve allows the air to exhaust until the pressure in cylinders is 60 pounds, which is used for the final stop. There is a duplex governor on the pump so that either the ordinary system or the high speed system may be used.

By order of the Safety Appliance Act of Congress, all rolling stock must be equipped with automatic air brakes by January, 1900. In view of this fact several of the railway companies have built instruction cars, which are in charge of air brake experts and in these cars all engine men and train men must receive lectures on air brake practice once a year and must attain a grade of 75 per cent. in an examination at the close of the lecture. Any failure suspends a man until he can bring up his deficiency.

The air brake was invented by an American, and ignoring vacuum, steam and other brakes, it has been perfected by Americans until we can point with pride to our railroads as the finest in the world.

A NOTABLE STUDENT GATHERING.

In the latter part of the present month, the 23d to 27th, inclusive, a great meeting of college students is to be held at Cleveland, Ohio. It is the regular triennial convention of the student volunteers for Foreign Missions. The convention will be attended by thousands of students from American colleges and universities, and by prominent religious leaders of all denominations from this and other countries. The present indications are that it will not only be the largest missionary gathering ever held in North America, or the world, but that it will be the largest student gathering ever brought together.

The great importance of this meeting in the influence which it must exert upon the student life of the higher institutions of learning in this country, calls attention to the organization which is the means of calling it together.

The subject of foreign missions appeals strongly to the college student from its educational side. He is interested in it as he is in anything having for an object the elevation and enlightenment of some portion of the race.

It will not do to forget that the whole grandly organized scheme of foreign missionary effort, as supported by the churches of this continent, owes its existence to the determination and zeal of a handful of students of Williams College, away back in the early years of this century. But about twelve years ago there was set on foot a movement which, small in its beginning, soon grew to be a strong inter-collegiate organization, and at the present time is firmly established in more than eight hundred institutions of the United States and Canada. It bears the name of the Student Volunteer Movement for Foreign Missions. The watchword of the society is "The evangelization of the world in the present generation." Its members stand ready to back up their convictions by their life service in the mission field if necessary. The society is most thoroughly organized and efficiently managed. It seeks to enroll among the students of the institutions of higher learning, volunteers who may be sent by the various Mission Boards to their fields of missionary service.

The success which has been met in this endeavor is unmistakable. The number of college students who are now in heathen lands and will spend the best part, if not the whole, of their lives there, mounts up into the hundreds. And the supply of volunteers still here at home, but who stand ready to go whenever the opportunity may present itself, is far in excess of the ability of the Boards to send them. These volunteers who remain here by force of circumstances are by no means simply idly waiting for the call to go to the scene of their chosen labors. If there is any one thing that the society believes in thoroughly it is that the highest ability, supplemented by the very best preparation possible for the work, is none too good. Accordingly, an extensive system of educational classes is maintained. The young man or young woman who has become so far impressed with the mighty plea for help which comes up from the benighted millions of heathen lands as to express a desire to devote a life's work in their behalf, is not encouraged, or even allowed, to enter upon the work blindly. The would-be foreign missionary is given a complete and up-to-date course of study of the present condition, the needs and requirements of the different countries forming the fields of missionary labor. If the applicant has made choice of a particular field or station, he studies thoroughly the language, the geography, the laws of the land, and the habits and customs of its people. He reads the published letters and other writings of missionaries already at work there, and, if possible, enters into personal correspondence with them. He thus, as it were, becomes acquainted with his work before he enters upon it. When perchance some one of the Mission Boards has selected him from a number of applicants, and commissioned him to go at last to the scenes where his eyes have long been turned, he lands from the vessel and sets foot upon ground already familiar. Bringing with him his college training in medicine, science, theology, or the classics, he is at once prepared to begin a work of ministration to those about him that will count from the beginning.

Even a slight knowledge of modern ideas in medicine and hygiene is often of incalculable value to the missionary. While the preaching of the Gospel of Christ is the prime motive in the work, yet it must many times be accompanied or preceded by the gospel of health and cleanliness. A number of schools have been established for the express purpose of training Medical Missionaries, as they have come to be called.

The Volunteer Movement is held in the highest estimation by those high in authority in evangelical churches and all Mission Boards recognize the significance of the movement and the importance of its aims. It has swept aside at one blow a great difficulty that lay in the way of effective missionary work by the church agencies. This was the question of finding men and women of the highest type of ability and culture with spiritual and professional training for the great work to be done. With the host of volunteers from the ranks of the college and university students pressing at their doors, the question has changed from "Where shall we find men?" to "How shall we send men?" With this problem of financial support of the missionaries in the field the Boards are now wrestling. To their aid come nobly the Student Volunteers, who are not permitted, for various reasons, to go themselves. They become in the capacities of ministers of churches, college professors, members of learned professions and leaders of men generally, the intelligent friends and promoters of the cause of foreign missions.

Seeing the results of the past few years' work of the organization in direct attainment of its objects and also the great interest awakened generally, as shown by such conventions of young people as that to be held in a few days in Cleveland, it seems as though the motto of the Volunteers bids fair to become history. Theirs it is to know that they are fulfilling the last command of their Master upon earth, "Go ye into all the world and preach the gospel to every creature."

O. E. McMEANS.

THE SOPHOMORE BANQUET.

ANY one present in the Gymnasium on Thursday, January the 20th, after the Sophomores had finished their regular class exercises, would undoubtedly have thought that the Sophomores were rehearsing for a concert. They were, however, but getting in good cheer for a banquet. Evidently they considered discretion the better part of valor, for either on account of their small numbers or because they thought a feast at the Terre Haute House would be much nicer than a lunch at Sage's, they gave the Freshmen no notice of their plans.

They left the Gymnasium in a body and shortly after 6:30 every member of the class was present in the rooms set apart for them at the hotel. Music and stories served to pass away the time until 8:20 o'clock, when they were called to the banquet hall. Dainty menu cards adorned each place at the table and about two hours were spent in doing justice to the feast.

The opening address of the evening was made by Mr. Loofbourow, President, which was followed by the address of the Toastmaster, Mr. Warfel. During this latter address, what appeared to be a five-cent bottle of carbon bisulphide was thrust into one of the hall windows. It caused but little commotion, however, and the toasts continued. Nearly every member of the class responded to the call of the Toastmaster and one responded in Norwegian. Two ex-class men were present during the rendering of the toasts and helped to make things merry for the remainder of the evening.

It was some time after the midnight hour before the final, "Hiro! Cairo!" rent the air and the members of the class departed for their homes, having thoroughly enjoyed their second banquet.

The following toasts were responded to:

Salutatory Address.......President Jesse H. Loofbourow
Address ....Toastmaster R. Roy Warfel
"Doc and His Family" ....Robert York
"Theatres — Comique and Otherwise" ....
..........................Thomas D. Witherspoon, Jr
"The Lady" ....Harry S. Richardson
"Dutch" ....Curtis A. Mees
"Subs" ....William C. Appleton
"Inventions".........................Charles J. Larson
"Precipitates and Residues"........Herbert F. Madison
"Other Dues".......................Frank W. Pfleging
"A New Story".......................J. Irving Brewer
"Wheels"............................Gustave A. Maier
"Ball Bearings"..................Eugene S. Boudinot

THE LECTURE COURSE.

On Thursday morning, Jan. 27th, Professor Wagner delivered a lecture on "A Historical Sketch of the Development of the Steam Engine," to the Seniors and Juniors; a few Professors were also present. This being the first of the series to be given by the Professors this term which will cover points not found in the regular courses.

The lecture covered such a range that it was necessarily an abstract of the subject, and to reabstract it for THE TECHNIC would render it quite disconnected and unintelligible to those who did not hear the original paper.

Professor Wagner had prepared a number of very fine lantern slides to illustrate the designs and growth of the steam engine, and their exhibition aided greatly in making the interesting paper very instructive as well. It is exceedingly interesting to look back now and see how crude were the first designs, and how difficult to originate practical ideas of the simplest nature, then with the embryo of a good idea once started how rapid the growth became.

The second lecture of the series was delivered Thursday afternoon, Feb. 10th, by Dr. Noyes, Professor of Chemisty. His subject: "Water Supply from a Chemical and Bacteriological Standpoint," was handled in his usual skillful manner. The chemical science is popularly one of profound mystery, and to those unversed in the science the chemist of to-day is as mysterious as the alchemist of the ancients; but Dr. Noyes is so clear in his explanations, and so logical in his arguments, that his lectures are exceedingly interesting and appreciated by all of his hearers. The lecture embraced the determinations made to ascertain the character of the water, these results are of value only when combined with the history of the water; for the significant point is to determine the degree of contamination from injurious sources, and not simply its chemical purity. The second part of the lecture dwelt upon the means of obtaining a safe water from one that is contaminated. All of the chemical steps taken in such an analysis were illustrated by experiment, and several typical waters were referred to.

Feb. 19th, Professor Howe, "Arches Used in Bridges."

SCIENTIFIC SOCIETY.

The monthly meeting of the Scientific Society was held Jan. 28th. The meeting was called to order by the President at 7:30 P. M. The minutes of the last meeting were called for and read, and matters of business were taken up. The question of the dues of the Society was discussed at length. The President stated that the treasury contained about ten dollars collected for dues in the past two years, and requested the expression of the opinions of the members as to whether this fund should be increased by further collection of dues. Mr. McLellan suggested that, as the Society had as yet had no need for money, the dues be indefinitely suspended, and that in case money were needed it could be raised by an assessment of the members. Mr. Hubbell moved that the Secretary be instructed to suspend the collection of dues until further notified, which motion was carried. There being no more business before the meeting, Mr. Butler's paper on "Air Brakes" was called for and read. The paper is published in this issue of The Technic, and it is to be regretted that the ingenious drawings and devices which he had prepared for the explanation of the paper can not be fully reproduced. The very few points which had not been fully illustrated in his paper were brought out afterwards in answers to questions of the members.

Mr. A. D. Kidder's paper on "Gold Mining Methods and Machinery" was next read and was well illustrated by slides which he had prepared for the purpose and was very interesting throughout. The gentlemen were thanked by the Society for their papers and the meeting was adjourned until Feb. 25th.

AIDS IN LIBRARY WORK.

The German proverb, „Gut begonnen, halb gewonnen" is peculiarly applicable to work in a library. It is a liberal education in itself to know how and where to find material upon any given subject when it is desired. To make accessible to the investigator the material buried in library alcoves, behind obscure titles and in the masses of periodical literature, has been the problem of librarians and bibliographers for the last half century. The result has been the bringing forth of many indexes, bibliographies, catalogues, etc., varying greatly in extensiveness and value. While our library is not as well supplied with such aids as one might wish, still we have some which will be found helpful.

INDEXES TO PERIODICAL LITERATURE.

1. Index to Engineering Literature, 1884-95. 2v. Indexes about 100 of the best American and foreign periodicals.
2. Poole's Index to Periodical Literature from about 1800 to 1892. 3v. A very exhaustive and accurate work but unfortunately contains index to very few scientific and technical works.

3. Wisconsin Engineer. Index to about 200 American and foreign periodicals from Jan. 1, 1896 to date. Published quarterly.
4. Knight's New Mechanical Dictionary. Contains indexical references to technical journals for 1876-1880.

Engineering Magazine. Contains a monthly digest of current engineering literature.

Electrical World. Contains weekly digest of current electrical literature.

Some of our periodicals have published general indexes. Among others may be mentioned the following found in our library:

Journal of the Franklin Institute. Index to Vols. 1 to 140. 1826-1895. 2v.

Messenger of Mathematics. Index to Vols. 1 to 25. 1871-1896. (Bound with Vol. 26).

LaNature. Index for 1873 to 1892. 2v.

Littell's Living Age. Index to Vols. 37 to 148. 1854-1881.

American Institute of Mining Engineers. Index to Vols. 1 to 15, 1871-1887, and 21 to 25, 1892-1897.

Royal SocietyCatalogue of Scientific Papers. 1800-1873. 8v.

BOOK CATALOGUES, ETC.

Publisher's Trade List Annual. Contains catalogues of the leading American publishers.

New Book List. A monthly list of new publications.

Critic. Contains reviews of non-scientific literature.

Bolton's Bibliography of Chemistry. A bibliography of the books on this subject published from 1492 to 1892.

The following, though of an advertising nature, will be found instructive and oftimes helpful:

Longmans, Green & Co. A monthly list of new books.

The Macmillan Co. Book reviews. A monthly devoted to new and current publications.

A. C. McClurg & Co. Bulletin of new books of various publishers. Monthly.

G. P. Putnam's Sons. Notes on new books. Monthly.

Gustav E. Stechert. Monthly list of new publications in all the principal European languages.

Catalogues of many other American publishers are received regularly.

ALBERT A. FAUROT.

Instructor.—"If he has not heard this fact, it will possibly be new to him."

McKibben, '01, translating German: "Life is short but the weather is cold."

Instructor Shepherd addressed the Rose Tech. Y. M. C. A., Wednesday evening, Jan. 26th.

Professor Place: "We have no other "Ryder" for the balance except the one that is using it."

Pirtles' fair correspondents have so much to tell him that their letters are now written in two editions.

The Freshmen say that the Sophomores were very discreet in keeping their banqueting intentions secret.

Mrs. Dickerson, of Atlantic, Iowa, is visiting her son, Dickerson, '01, and will be in the city for a few days.

Schneider, '98, should be more careful how he addresses Lansden when Professor Gray is entering the room.

Kittredge, '01, has proceeded so far in learning his letters that he can almost say his alphabet in correct order.

Dryer, '01, has recently made exhaustive experiments as to the suitability of a lumber pile as a place of repose.

Larson in quaternions: "Professor, I don't see that." A classmate: "Well, you better take a front seat then."

Wanted—Copy of THE TECHNIC for October, '91, I: 1; June, '95, IV: 9; and December, '93, III: 3. Business Manager.

The class of '99 would be very much indebted to Kidder if he would explain which is the "back side of the earth."

Instructor.—"Are there any questions on yesterday's quiz?"

Clay, '01.—"How do you do it?"

Instructor.—"This sand is not fine enough for moulding."

Schwartz, '01.—"Is it too coarse?"

Professor Kendrick evidently thinks that Kittridge, '99, is accustomed to mistaking the electric lights for stars on Saturday night.

Howell to Professor Wickersham during a quiz in French: "You don't object to our using a slide rule or Kent, do you, Professor?"

On account of illness, Hubbell, '98, was unable to attend the convention of I. I. A. A. delegates at Indianapolis, and Howell, '99, was sent in his place.

Keyes, '99, translating French: "I shall ultimately get into a heated trouble." And then he wanted to know: "What t— —l are you laughing about?"

Some one inquired at the shop the other day what it would cost to make a piece of machinery "about the size of a stick of chalk and as long as a piece of string."

One of the Juniors after a five minute futile attempt to open his locker chanced to notice that he had been trying his combination on the locker next to his own.

Within the past few weeks the Freshmen seem to have become addicted to "monkeying with the buzz-saw." Shepard, Hadley, and Dussan have each been slightly injured.

President Mees delivered the commencement address at the graduation exercises of the midwinter class of the High School, Friday evening, January the twenty-eighth.

The Juniors were discussing the diving bell and the relation of the air pressure, when Holiger said: "You can't regulate the pressure of the atmosphere with an air pump, can you?"

Madison to his opponent, just as the men lined up for a basket ball game: "Let's shake hands now for a nice clean game, and if I hurt you during the game please remember that I didn't mean to."

A certain Normal in a geometry recitation recently defined a dihedral angle as the place where two faces meet. It is to be wondered if he was not thinking that he was in a recitation on Girlology.

Dr. Mees expressing his experience with the Freshmen: "People are generally supposed to have more brains than feet, but lately I have been compelled to change my opinion in regard to some persons."

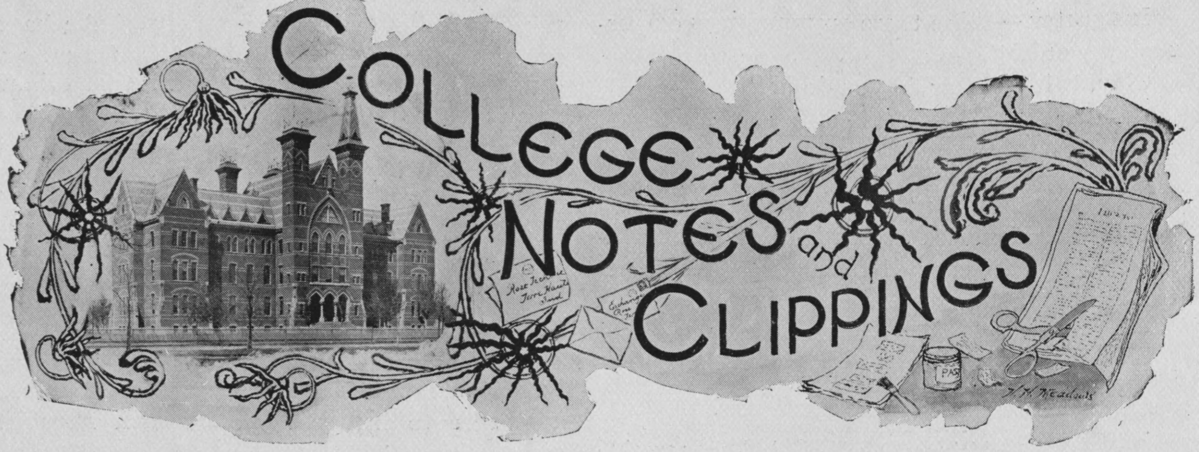
Stone, '99, wears a sweater marked "Hottentot," a bicycle organization of which he is charter member. During a basket ball game a spectator was overheard to make the remark: "My, but he is a Hot Tot sure enough."

The Seniors were listening to a lecture on power and had been a little excessive in asking questions. The Professor had introduced various symbols such as *O*, *I*, *F*, etc., when Roberts asked: "What did you say *I* was?"

Professor Wagner had been lecturing on water pressure engines and made the statement: "The piston is made water tight." During a moment of silence which followed Freudenreich said to Hubbel: "Did you ever get tight on water?"

Professor Hathaway read a paper before the Terre Haute Literary Club at their meeting in January. His paper, "A Summer Ocean Cruise," was greatly appreciated and quite surprised the members at first, for the Professor was not known to be such a sportsman.

The frequent patronage of the gymnasium by Professors Hathaway, McCormick, McMeans, and Shepherd adds a stimulus and encouragement for the boys to do as well in appreciating the privileges. Their presence also aids greatly towards the organization and supervision of games.



Hockey and indoor base ball are occupying the attention of the eastern athletes this winter.

The *Stentor* gives a rather ludicrous example of German Etymology, if it may be called such, that is worth reading.

Discus throwing is expected to take the place of the mile walk in a great many college meets this spring.—*Wesleyan Argus.*

The Honor system has been discussed to a great extent recently and the *Wesleyan Argus* tells of its workings at that place.

The last issue of the *Engineering Record* has a description of syphoning on a large scale at Cleveland, Ohio, that is very interesting.

The Freshman pipe rush is of so grave importance at the *University of Pennsylvania* that a meeting of all four classes was called to consider the ethics of the affair and establish some rules governing it.

The first number of the *Tech* is received. It gives an account of the opening ceremonies of Bradley Polytechic Institute, Peoria, Ill., a recently organized school, and a history of its founder, Mrs. Lydia Bradley.

Of the new exchanges which have appeared this month, we acknowledge the following: *The Tech*, Bradley Polytechnic Institute; *College Magazine*, Arkansas College; *The College Beacon*, St. Johns' Lutheran; *The University Record*, University of Chicago.

The *College Athlete* for February is a budget of foot ball notes. It contains a summary of the past season mentioning nearly every team in the country and gives pictures of many. Teams and players are rated and there is quite an amount of readable matter regarding individuals.

In one of the papers received by us the exchange column is made up of laudatory comments on itself, gleaned from other papers. That, of course, is very interesting reading matter for the editors of that paper, and while we do not want to entertain ourselves too much, we would like to give thanks for the kind mentions of our Holiday number.

Apparently the production of large and well filled Christmas exchanges was the result of an accumulation of material rather than a redraft on the various staffs, for the January issues in nearly all instances are up to standard. Special mention is made of *The Observer*, *Miscellany*, *Rensselaer Polytechnic*, *Wellesley Magazine* and *The Unit.*

The *Indiana University Student* contains an article in which it sets forth the brilliant work of Meriwether as full back of the Polytechnic foot ball team during the last season. The article gives a short sketch of his foot ball career, before and after entering Rose, and concludes by saying that "Meriwether, without doubt, stands at the head of the list of full backs of the colleges of Indiana."